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The Technical Communication Practices of U.S. Aerospace Engineers and Scientists: Results of the Phase 1 Mail Survey – Aircraft Design Perspective

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THE TECHNICAL COMMUNICATIONS PRACTICES OF U.S. AEROSPACE ENGINEERS AND SCIENTISTS: RESULTS OF THE PHASE 1 MAIL SURVEY—AIRCRAFT DESIGN PERSPECTIVE

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ABSTRACT

The U.S. government technical report is a primary means by which the results of federally funded research and development (R&D) are transferred to the U.S. aerospace industry. However, little is known about this information product in terms of its actual use, importance, and value in the transfer of federally funded R&D. Little is also known about the intermediary-based system that is used to transfer the results of federally funded R&D to the U.S. aerospace industry. To help establish a body of knowledge, the U.S. government technical report is being investigated as part of the *NASA/DoD Aerospace Knowledge Diffusion Research Project.* In this report, we summarize the literature on technical reports, present a model that depicts the transfer of federally funded aerospace R&D via the U.S. government technical report, and present the results of research that investigated aerospace knowledge diffusion vis-à-vis the technical communication practices of U.S. aerospace engineers and scientists who were members of the American Institute of Aeronautics and Astronautics.

INTRODUCTION

NASA and the DoD maintain scientific and technical information (STI) systems for acquiring, processing, announcing, publishing, and transferring the results of government-performed and government-sponsored research. Within both the NASA and DoD STI systems, the U.S. government technical report is considered a primary mechanism for transferring the results of this research to the U.S. aerospace community. However, McClure (1988) concludes that we actually know little about the role, importance, and impact of the technical report in the transfer of federally funded R&D because little empirical information about this product is available.

We are examining the system(s) used to diffuse the results of federally funded aerospace R&D as part of the *NASA/DoD Aerospace Knowledge Diffusion Research Project.* This project investigates, among other things, the information-seeking behavior of U.S. aerospace engineers and scientists, the factors that influence the use of STI, and the role played by U.S. government technical reports in the diffusion of federally funded aerospace STI (Pinelli, Kennedy, and Barclay, 1991; Pinelli, Kennedy, Barclay, and White, 1991). The results of this investigation could (1) advance the development of practical theory, (2) contribute to the design and development of aerospace information systems, and (3) have practical implications for transferring the results of federally funded aerospace R&D to the U.S. aerospace community. The project fact sheet is Appendix A.

In this report, we summarize the literature on technical reports, provide a model that depicts the transfer of federally funded aerospace R&D through the U.S. government technical report, and present the results of the Phase 1 mail survey that focused on the technical communication practices of U.S. aerospace engineers and scientists. We summarize the findings of the Phase 1 mail survey in terms of the technical communication practices of U.S. aerospace engineers and scientists who were members of the American Institute of Aeronautics and Astronautics.

THE U.S. GOVERNMENT TECHNICAL REPORT

Although they have the potential for increasing technological innovation, productivity, and economic competitiveness, U.S. government technical reports may not be utilized because of limitations in the existing transfer mechanism. According to Ballard, et al., (1986), the current system "virtually guarantees that much of the Federal investment in creating STI will not be paid back in terms of tangible products and innovations." They further state that "a more active and coordinated role in STI transfer is needed at the Federal level if technical reports are to be better utilized."

Characteristics of Technical Reports

The definition of the technical report varies because the report serves different roles in communication within and between organizations. The technical report has been defined etymologically, according to report content and method (U.S. Department of Defense, 1964); behaviorally, according to the influence on the reader (Ronco, et al., 1964); and rhetorically, according to the function of the report within a system for communicating STI (Mathes and Stevenson, 1976). The boundaries of technical report literature are difficult to establish because of wide variations in the content, purpose, and audience being addressed. The nature of the report -- whether it is informative, analytical, or assertive -- contributes to the difficulty.

Fry (1953) points out that technical reports are heterogenous, appearing in many shapes, sizes, layouts, and bindings. According to Smith (1981), "Their formats vary; they might be brief (two pages) or lengthy (500 pages). They appear as microfiche, computer printouts or vugraphs, and often they are loose leaf (with periodic changes that need to be inserted) or have a paper cover, and often contain foldouts. They slump on the shelf, their staples or prong fasteners snag other documents on the shelf, and they are not neat."

Technical reports may exhibit some or all of the following characteristics (Gibb and Phillips, 1979; Subramanyam, 1981):

- Publication is not through the publishing trade.
- Readership/audience is usually limited.
- Distribution may be limited or restricted.

- Content may include statistical data, catalogs, directions, design criteria, conference papers and proceedings, literature reviews, or bibliographies.

- Publication may involve a variety of printing and binding methods.

The SATCOM report (National Academy of Sciences - National Academy of Engineering, 1969) lists the following characteristics of the technical report:

- It is written for an individual or organization that has the right to require such reports.

- It is basically a stewardship report to some agency that has funded the research being reported.

- It permits prompt dissemination of data results on a typically flexible distribution basis.

- It can convey the total research story, including exhaustive exposition, detailed tables, ample illustrations, and full discussion of unsuccessful approaches.

History and Growth of the U.S. Government Technical Report

The development of the [U.S. government] technical report as a major means of communicating the results of R&D, according to Godfrey and Redman (1973), dates back to 1941 and the establishment of the U.S. Office of Scientific Research and Development (OSRD). Further, the growth of the U.S. government technical report coincides with the expanding role of the Federal government in science and technology during the post World War II era. However, U.S. government technical reports have existed for several decades. The Bureau of Mines *Reports of Investigation* (Redman, 1965/66), the *Professional Papers of the United States Geological Survey*, and the *Technological Papers of the National Bureau of Standards* (Auger, 1975) are early examples of U.S. government technical reports. Perhaps the first U.S. government publications officially created to document the results of federally funded (U.S.) R&D were the technical reports first published by the National Advisory Committee for Aeronautics (NACA) in 1917.

Auger (1975) states that "the history of technical report literature in the U.S. coincides almost entirely with the development of aeronautics, the aviation industry, and the creation of the NACA, which issued its first report in 1917." In her study, *Information Transfer in Engineering*, Shuchman (1981) reports that 75% of the engineers she surveyed used technical reports; that technical reports were important to engineers doing applied work; and that aerospace engineers, more than any other group of engineers, referred to technical reports. However, in many of these studies, including Shuchman's, it is often unclear whether U.S. government technical reports, non-U.S. government technical reports, or both are included (Pinelli, 1991a).

The U.S. government technical report is a primary means by which the results of federally funded R&D are made available to the scientific community and are added to the literature of

science and technology (President's Special Assistant for Science and Technology, 1962). McClure (1988) points out that "although the [U.S.] government technical report has been variously reviewed, compared, and contrasted, there is no real knowledge base regarding the role, production, use, and importance [of this information product] in terms of accomplishing this task." Our analysis of the literature supports the following conclusions reached by McClure:

- The body of available knowledge is simply inadequate and noncomparable to determine the role that the U.S. government technical report plays in transferring the results of federally funded R&D.

- Further, most of the available knowledge is largely anecdotal, limited in scope and dated, and unfocused in the sense that it lacks a conceptual framework.

- The available knowledge does not lend itself to developing "normalized" answers to questions regarding U.S. government technical reports.

THE TRANSFER OF FEDERALLY FUNDED AEROSPACE R&D AND THE U.S. GOVERNMENT TECHNICAL REPORT

Three paradigms -- appropriability, dissemination, and diffusion -- have dominated the transfer of federally funded (U.S.) R&D (Ballard, et al., 1989; Williams and Gibson, 1990). Whereas variations of them have been tried within different agencies, overall Federal (U.S.) STI transfer activities continue to be driven by a "supply-side," dissemination model.

The Appropriability Model

The **appropriability model** emphasizes the production of knowledge by the Federal government that would not otherwise be produced by the private sector and competitive market pressures to promote the use of that knowledge. This model emphasizes the production of basic research as the driving force behind technological development and economic growth and assumes that the Federal provision of R&D will be rapidly assimilated by the private sector. Deliberate transfer mechanisms and intervention by information intermediaries are viewed as unnecessary. Appropriability stresses the supply (production) of knowledge in sufficient quantity to attract potential users. Good technologies, according to this model, sell themselves and offer clear policy recommendations regarding Federal priorities for improving technological development and economic growth. This model incorrectly assumes that the results of federally funded R&D will be acquired and used by the private sector, ignores the fact that most basic research is irrelevant to technological innovation, and dismisses the process of technological innovation within the firm.

The Dissemination Model

The **dissemination model** emphasizes the need to transfer information to potential users and embraces the belief that the production of quality knowledge is not sufficient to ensure its fullest

use. Linkage mechanisms, such as information intermediaries, are needed to identify useful knowledge and to transfer it to potential users. This model assumes that if these mechanisms are available to link potential users with knowledge producers, then better opportunities exist for users to determine what knowledge is available, acquire it, and apply it to their needs. The strength of this model rests on the recognition that STI transfer and use are critical elements of the process of technological innovation. Its weakness lies in the fact that it is passive, for it does not take users into consideration except when they enter the system and request assistance. The **dissemination model** employs one-way, source-to-user transfer procedures that are seldom responsive in the user context. User requirements are seldom known or considered in the design of information products and services.

The Knowledge Diffusion Model

The **knowledge diffusion model** is grounded in theory and practice associated with the diffusion of innovation and planned change research and the clinical models of social research and mental health. Knowledge diffusion emphasizes "active" intervention as opposed to dissemination and access; stresses intervention and reliance on interpersonal communications as a means of identifying and removing interpersonal barriers between users and producers; and assumes that knowledge production, transfer, and use are equally important components of the R&D process. This approach also emphasizes the link between producers, transfer agents, and users and seeks to develop user-oriented mechanisms (e.g., products and services) specifically tailored to the needs and circumstances of the user. It makes the assumption that the results of federally funded R&D will be under utilized unless they are relevant to users and ongoing relationships are developed among users and producers. The problem with the knowledge diffusion model is that (1) it requires a large Federal role and presence and (2) it runs contrary to the dominant assumptions of established Federal R&D policy. Although U.S. technology policy relies on a "dissemination-oriented" approach to STI transfer, other industrialized nations, such as Germany and Japan, are adopting "diffusion-oriented" policies which increase the power to absorb and employ new technologies productively (Branscomb, 1992; Branscomb, 1991).

The Transfer of (U.S.) Federally-Funded Aerospace R&D

A model depicting the transfer of federally funded aerospace R&D through the U.S. government technical report appears in figure 1. The model is composed of two parts -- the **informal** that relies on collegial contacts and the **formal** that relies on surrogates, information producers, and information intermediaries to complete the "producer to user" transfer process.

When U.S. government (i.e., NASA) technical reports are published, the initial or primary distribution is made to libraries and technical information centers. Copies are sent to surrogates for secondary and subsequent distribution. A limited number of copies are set aside to be used by the author for the "scientist-to-scientist" exchange of information at the collegial level.

Surrogates serve as technical report repositories or clearinghouses for the producers and include the Defense Technical Information Center (DTIC), the NASA Center for Aero Space

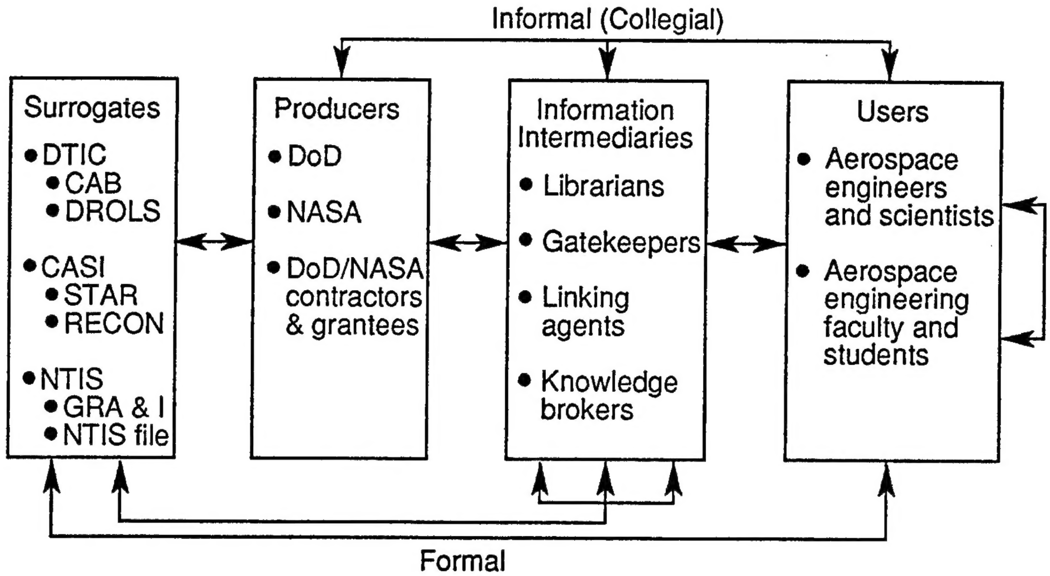

Figure 1. The U.S. Government Technical Report in a Model Depicting the Dissemination of Federally Funded Aerospace R&D.

Information (CASI), and the National Technical Information Service (NTIS). These surrogates have created a variety of technical report announcement journals such as *CAB* (Current Awareness Bibliographies), *STAR* (Scientific and Technical Aerospace Reports), and *GRA&I* (Government Reports Announcement and Index) and computerized retrieval systems such as *DROLS* (Defense RDT&E Online System), *RECON* (REsearch CONnection), and NTIS *On-line* that permit online access to technical report data bases. Information intermediaries are, in large part, librarians and technical information specialists in academia, government, and industry. Those representing the producers serve as what McGowan and Loveless (1981) describe as "knowledge brokers" or "linking agents." Information intermediaries connected with users act, according to Allen (1977), as "technological entrepreneurs" or "gatekeepers." The more "active" the intermediary, the more effective the transfer process becomes (Goldhor and Lund, 1983). Active intermediaries move information from the producer to the user, often utilizing interpersonal (i.e., face-to-face) communication in the process. Passive information intermediaries, on the other hand, "simply array information for the taking, relying on the initiative of the user to request or search out the information that may be needed" (Eveland, 1987).

The overall problem with the total Federal STI system is that "the present system for transferring the results of federally funded STI is passive, fragmented, and unfocused;" effective knowledge transfer is hindered by the fact that the Federal government "has no coherent or systematically designed approach to transferring the results of federally funded R&D to the user" (Ballard, et al., 1986). In their study of issues and options in Federal STI, Bikson and her colleagues (1984) found that many of the interviewees believed "dissemination activities were afterthoughts, undertaken without serious commitment by Federal agencies whose primary

concerns were with [knowledge] production and not with knowledge transfer;" therefore, "much of what has been learned about [STI] and knowledge transfer has not been incorporated into federally supported information transfer activities."

Problematic to the **informal** part of the system is that knowledge users can learn from collegial contacts only what those contacts happen to know. Ample evidence supports the claim that no one researcher can know about or keep up with all the research in his/her area(s) of interest. Like other members of the scientific community, aerospace engineers and scientists are faced with the problem of too much information to know about, to keep up with, and to screen. Further, information is becoming more interdisciplinary in nature and more international in scope.

Two problems exist with the **formal** part of the system. First, the **formal** part of the system employs one-way, source-to-user transmission. The problem with this kind of transmission is that such formal one-way, "supply side" transfer procedures do not seem to be responsive to the user context (Bikson, et al., 1984). Rather, these efforts appear to start with an information system into which the users' requirements are retrofit (Adam, 1975). The consensus of the findings from the empirical research is that interactive, two-way communications are required for effective information transfer (Bikson, et al., 1984).

Second, the **formal** part relies heavily on information intermediaries to complete the knowledge transfer process. However, a strong methodological base for measuring or assessing the effectiveness of the information intermediary is lacking (Beyer and Trice, 1982). In addition, empirical data on the effectiveness of information intermediaries and the role(s) they play in knowledge transfer are sparse and inconclusive. The impact of information intermediaries is likely to be strongly conditional and limited to a specific institutional context.

According to Roberts and Frohman (1978), most Federal approaches to knowledge utilization have been ineffective in stimulating the diffusion of technological innovation. They claim that the numerous Federal STI programs are "highest in frequency and expense yet lowest in impact" and that Federal "information dissemination activities have led to little documented knowledge utilization." Roberts and Frohman also note that "governmental programs start to encourage utilization of knowledge only after the R&D results have been generated" rather than during the idea development phase of the innovation process. David (1986), Mowery (1983), and Mowery and Rosenberg (1979) conclude that successful [Federal] technological innovation rests more with the transfer and utilization of knowledge than with its production.

THE INFORMATION-SEEKING BEHAVIOR OF ENGINEERS

The information-seeking behavior of engineers and scientists has been variously studied by information and social scientists, the earliest studies having been undertaken in the late 1960s (Pinelli, 1991b). The results of these studies have not accumulated to form a significant body of knowledge that can be used to develop a general theory regarding the information-seeking behavior of engineers and scientists. The difficulty in applying the results of these studies has

been attributed to the lack of a unifying theory, a standardized methodology, and the common definitions (Rohde, 1986).

Despite the fact that numerous "information use" studies have been conducted, the information-seeking behavior of engineers and information use in engineering are neither broadly known nor well understood. There are a number of reasons (Berul, et al., 1965): (1) many of the studies were conducted for narrow or specific purposes in unique environments such as experimental laboratories; (2) many, if not most, of them focused on scientists exclusively or engineers working in a research environment; (3) few studies have concentrated on engineers, especially engineers working in manufacturing and production; (4) from an information use standpoint, some engineering disciplines have yet to be studied; (5) most of the studies have concentrated on the users' use of information in terms of a library and/or specific information packages such as professional journals rather than how users produce, transfer, and use information; and (6) many of the studies, as previously stated, were not methodologically sophisticated and few included testable hypotheses or valid procedures for testing the study's hypotheses.

Further, we know very little about the diffusion of knowledge in specific communities such as aerospace. In the past 25 years, few studies have been devoted to understanding the information environment in which aerospace engineers and scientists work, the information-seeking behavior of aerospace engineers and scientists, and the factors that influence the use of federally funded aerospace STI. Presumably, the results of such studies would have implications for current and future aerospace STI systems and for making decisions regarding the transfer and use of federally funded aerospace STI.

RESULTS OF THE PHASE 1 MAIL SURVEY— AIRCRAFT DESIGN PERSPECTIVE

This research was conducted as a Phase 1 activity of the *NASA/DoD Aerospace Knowledge Diffusion Research Project.* Survey participants consisted of U.S. aerospace engineers and scientists who were members of the American Institute of Aeronautics and Astronautics. All of the members in the sample were employed in the industry portion of U.S. aerospace. The survey instrument appears as Appendix B.

The Survey

The questionnaire used in this study was jointly prepared by the project team and representatives from the Indiana University Center for Survey Research (CSR). The survey was pretested on a group of aerospace engineers and scientists across the country. The Indiana University staff prepared an envelope for each individual that contained an 11-page questionnaire and the cover letter. In March 1996, a sample of 300 members of the American Institute of Aeronautics and Astronautics who identified their technical interest as aircraft design was selected for the study. The envelopes were packaged and mailed to the NASA Langley Research Center

(LaRC) on March 22, 1996, for mailing. The envelopes were mailed from NASA LaRC on March 27, 1996.

Between April 3, 1996 and April 29, 1996, 142 usable questionnaires were returned. Twenty nine questionnaires were returned as unusable because (1) the recipient was no longer working in aerospace, (2) the survey was not applicable to them, or (3) the recipient had retired.

By April 29, 1996, the survey cut-off date, 142 usable questionnaires had been received; the adjusted completion rate for the survey was 57%.

Data Collection and Analysis

A variation of Flanagan's (1954) critical incident technique was used to guide data collection. According to Lancaster (1978), the theory behind the critical incident technique is that it is much easier for people to recall accurately what they did on a specific occurrence or occasion than it is to remember what they do in general. Respondents were asked to categorize the most important job-related projects, task, or problem they had worked on in the past 6 months. The categories included (1) research, (2) design, (3) development, (4) manufacturing, (5) production, (6) quality assurance/control, (7) computer applications, (8) management, and (9) other.

Respondents were also asked to rate the amount of technical uncertainty and complexity they faced when they started their most important project, task, or problem. Technical uncertainty and complexity were measured on 5-point scales (1.0 = little uncertainty; 5.0 = great uncertainty; 1.0 = little complexity, 5.0 = great complexity). Survey participants were also asked to indicate whether they worked alone or with others in completing/solving the most important job-related project, task, or problem they had worked on in the past 6 months.

Technical uncertainty, complexity, and the importance of federally funded aerospace R&D were measured using ordinal scales. Hours spent communicating and the number of journal articles, conference-meeting papers, and U.S. government technical reports used were measured on an interval scale. Use of formal information sources and federally funded aerospace R&D were measured using a nominal scale. Data analysis was based on 142 responses, the total number of usable questionnaires received by the established cut-off date.

DESCRIPTIVE FINDINGS

Survey demographics for the 142 respondents appear in table 1. The following "composite" participant profile was developed for the respondents: works in industry (100%), has a master's degree (50.7%), has an average of 22.4 years of work experience in aerospace, was educated as and works as an engineer (94.4%, 89.4%), works in design/development (61.7%), and is male (97.2%).

Project, Task, Problem

Survey participants were asked to categorize the most important job-related project, task, or problem they had worked on in the past 6 months. The categories and responses are listed in table 2. A majority of the job-related projects, tasks, and problems (70%) were categorized as design/development. About 15% and 6% of the job-related projects, tasks, and problems were categorized as management and manufacturing/production, respectively. Most respondents (86%) worked with others (did not work alone) in completing their most important job-related project, task, or problem.

Number of Groups and Group Size. On average, respondents worked with 4.8 groups; each group contained an average of 10.4 members (table 2). A majority of respondents (76.8%) performed engineering duties while working on their most important job-related project, task, or problem. About 21% performed management duties.

Project, Task, Problem Complexity and Uncertainty. Respondents were asked to rate the overall complexity of their most important job-related project, task, or problem. The mean complexity score was 4.2 (of a possible 5.00). Respondents were also asked to rate the amount of technical uncertainty they faced when they started their most important project, task, or problem. The average (mean) technical uncertainty score was 3.7 (of a possible 5.00).

Correlation coefficients (Pearson's *r*) **were calculated to compare (1) the overall "level of project, task, or problem complexity" and "technical uncertainty" and (2) the level of "project, task, or problem complexity by category" and "technical uncertainty."** The correlation coefficients appear in table 3. Positive and significant correlations were found for both comparisons. These findings support the hypothesis that there is a (positive) relationship between technical uncertainty and complexity.

Project, Task, or Problem and Information Use. Respondents were given a list of the following information sources used to complete their most important job-related project, task, or problem: (1) used personal stores of technical information, (2) spoke with coworkers inside the organization, (3) spoke with colleagues outside of the organization, (4) used literature resources in the organization's library, (5) searched (or had someone search) an electronic (bibliographic) database, and (6) spoke with a librarian/technical information specialist. They were asked to identify the steps they followed to obtain needed information by sequencing these items (e.g.,

Table 1. Survey Demographics
[n = 142]

Demographics	Percentage	Number
Do You Currently Work In:		
Industry	100.0	142
Is Any Of Your Work Funded By The Federal Government:		
Yes	60.9	84
No	39.1	54
Your Highest Level Of Education:		
No Degree	1.4	2
Bachelor's Degree	38.7	55
Master's Degree	50.7	72
Doctorate	7.7	11
Other Type Of Degree	1.4	2
Your Years In Aerospace:		
0 years	0.7	1
1 Through 5 Years	4.9	7
6 Through 10 Years	17.6	25
11 Through 20 Years	26.8	38
21 Through 40 Years	41.5	59
41 Or More Years	8.5	12
Mean = 22.4 Years Median = 22.0 Years		
Your Education:		
Engineer	94.4	134
Scientist	4.9	7
Other	0.7	1
Your Primary Duties:		
Engineer	89.4	127
Scientist	2.1	3
Other	8.5	12
Is Your Work Best Classified As:		
Quality Assurance/Control	---	---
Research	6.4	9
Administration/Management	17.7	25
Design/Development	61.7	87
Manufacturing/Production	5.0	7
Service/Maintenance	0.7	1
Marketing/Sales	0.7	1
Flight Test	0.7	1
Other	7.1	10
Your Gender:		
Female	2.8	4
Male	97.2	137

Table 2. Project, Task, or Problem Categorization

Factors	Percentage	Number
Categories Of Project, Task, Or Problem:		
Quality Assurance/Control	0.0	0
Research	5.6	8
Design/Development	69.7	99
Manufacturing/Production	6.3	9
Computer Applications	1.4	2
Management	14.8	21
Other	2.1	3
Worked On Project, Task Or Problem:		
Alone	14.1	20
With Others	85.9	122
Mean Number Of Groups = 4.8		
Mean Number of People/Group = 10.4		
Nature Of Duties Performed:		
Engineering	76.8	109
Science	1.4	2
Management	21.1	30
Other	0.7	1

Table 3. Correlation of Project Complexity and Technical Uncertainty by Type of Project, Task, or Problem

Complexity - Uncertainty Correlation	n	*r*
Overall[a]	141	0.38**
Quality Assurance/Control	0	0.00
Research	8	0.86**
Design/Development	99	0.29**
Manufacturing/Production	9	0.44
Management	20	0.47*
Computer Applications	2	1.00
Other	3	0.50

[a] Overall mean complexity (uncertainty) score = 4.2 (3.7) out of a possible 5.00.
* *r* values are statistically significant at $p \leq 0.05$.
** *r* values are statistically significant at $p \leq 0.01$.

#1,#2,#3,#4, #5, and #6). They were instructed to place an "X" beside the step(s) (i.e., information source) they did not use. The results appear in table 4.

Table 4. Information Sources Used to Solve Project, Task, or Problem

Information Source	Used First %	Used Second %	Used Third %	Used Fourth %	Used Fifth %	Used Sixth %	Not Used %
Personal Store Of Technical Information	62.4	16.5	13.5	3.8	1.5	0.8	1.5
Spoke With Coworker(s) Inside The Organization	28.2	51.9	10.7	3.1	2.3	0.8	3.1
Spoke With Colleagues Outside Of The Organization	4.5	17.3	39.8	15.0	6.8	3.8	12.8
Used Literature Resources In My Organization's Library	1.6	4.0	12.9	29.0	12.9	8.1	31.5
Spoke With A Librarian/ Technical Information Specialist	1.6	4.0	7.1	11.1	12.7	10.3	53.2
Searched (Or Had Someone Search For Me) An Electronic (Bibliographic) Data Base	3.1	7.9	12.6	16.5	15.0	4.7	40.2

Use of Federally Funded Aerospace R&D. About 70% (100) of the participants used the results of federally funded aerospace R&D in their work. Respondents who used federally funded aerospace R&D in their work were given a list of 12 sources. They were asked to indicate how they learned about the results of federally funded aerospace R&D from each of the 12 sources (Table 5). Of the six most frequently used sources, half involve interpersonal communication and half are formal communication. Two of the five "federal initiatives" (i.e., NASA and DoD technical reports and NASA and DoD contacts) was among the six sources used most frequently to learn about the results of federally funded aerospace R&D. However, three of the five "federal initiatives" were used least often to learn about the results of federally funded aerospace R&D.

The respondents who reported using the results of federally funded aerospace R&D were asked if they used these results in completing the most important job-related project, task, or problem they had worked on in the past 6 months. The 55% (78) of respondents who answered "yes" were asked about the importance of these results in completing the project, task, or problem. A 5-point scale (1.0 = not at all important, 5.0 = very important) was used to measure importance. The mean importance rating was 3.9. Almost 66% of those who used federally funded R&D (51 respondents) responded with an importance rating of "4" or "5". About 60% (47) of those who used the results of federally funded aerospace R&D in completing their most important job-related project, task, or problem indicated that the results were published in either a NASA or DoD technical report.

Table 5. Sources Used to Learn About
the Results of Federally Funded Aerospace R&D

Source	Percentage	Number
1. Professional And Society Journals	72.1	49
2. Coworkers Inside My Organization	90.3	65
3. Trade Journals	56.1	37
4. NASA And DoD Technical Reports	75.7	53
5. Colleagues Outside My Organization	71.4	50
6. NASA And DoD Contacts	62.3	43
7. Professional And Society Meetings	41.5	27
8. Searches of Computerized Data Bases	53.0	35
9. NASA And DoD Sponsored Conferences And Workshops	31.7	20
10. Visits To NASA And DoD Facilities	44.8	30
11. Publications Such As *STAR*	19.0	12
12. Librarians Inside My Organization	43.1	28

The respondents who used the results of federally funded aerospace R&D in completing their most important job-related project, task, or problem were asked which problems, if any, they encountered in using these results (see table 6). Respondents were given a list of six problems from which to choose. About 67% indicated that the "time and effort it took to locate the results" was a problem. About 64% reported that the "time and effort it took to physically obtain the results" was a problem. About 28% indicated that "accuracy, precision, and reliability of the results" was a problem, and about 40% reported that "distribution limitations or security restrictions" constituted a problem. About 18%/22% indicated that "organization or format"/"legibility or readability" of the results constituted a problem.

Technical Communications Practices

Data which describe factors concerning the production and use of technical information are summarized in table 7. Participants were asked to indicate the importance of communicating technical information effectively (e.g., producing written materials or oral discussions). A 5-point scale was used to measure importance (1.0 = not at all important; 5.0 = very important).

Importance and Time Spent. The mean importance rating was 4.7; approximately 94% of respondents indicated that it was important to communicate technical information effectively. Respondents were also asked to report the total number of hours per week they had spent communicating technical information, both in written form and orally, during the past 6 months. Respondents reported spending slightly less time on producing written materials (an average of

Table 6. Problems Related to Use of Federally-Funded Aerospace R&D

Problem	Percentage	Number
Time And Effort To Locate Results	66.7	52
Time And Effort To Obtain Results	64.1	50
Accuracy, Precision And Reliability Of Results	28.2	22
Distribution Limitations Or Security Restrictions Of Results	39.7	31
Organization Or Format Of Results	17.9	14
Legibility Or Readability Of Results	21.8	17

11.7 hours/week) than oral discussions (an average of 13.0 hours/week). Approximately 71% of the respondents indicated that the amount of time they spent communicating technical information to others had increased over the past 5 years. About 4% indicated a decrease in the amount of time spent communicating technical information to others over the same period.

Respondents were also asked to report the total number of hours per week spent working with technical information, both written and oral, received from others in the past 6 months (see table 7). Respondents reported spending more time working with written technical information received from others (an average of 10.3 hours/week) than with technical information received orally from others (an average of 8.9 hours/week). Approximately 67% of the respondents indicated that, as they have advanced professionally, the amount of time spent working with technical information received from others had increased. About 5% indicated a decrease in the amount of time they spent working with technical information received from others.

Collaborative Writing. An attempt was made to determine the amount of writing in U. S. aerospace that is collaborative. Survey participants were asked to indicate the percentage of their written technical communications in the past 6 months that involved writing alone, with one other person, with a group of two to five people, and with a group of more than five people. About 23% of the survey respondents indicated that 100% of the written technical communications they prepared involved writing alone. [The mean percent was ($\bar{X}$ = 66.7) and the median percent was 80.0.] About 57% indicated that their written technical communications involved writing with one other person. [The mean percent was ($\bar{X}$ = 11.4) and the median percent was 5.0.] About 59% indicated that their written technical communications involved writing with a group of two to five people. [The mean percent was ($\bar{X}$ = 14.8) and the median percent was 10.0.] About 29% indicated that their written technical communications involved writing with a group of more than five people. [The mean percent was ($\bar{X}$ = 7.2) and the median percent was 0.0.]

Table 7. Technical Communications: Importance, Time Spent, and Change Over Time

Communication And Receipt Of Information	Percentage	Number
Importance Of Communicating Technical Information:		
Unimportant	1.4	2
Neither Important Nor Unimportant	4.9	7
Important	93.7	133
Mean = 4.7 Median = 5.0		
Time Spent Producing Written Technical Information:		
0 Hours Per Week	---	---
1 Through 5 Hours Per Week	26.1	37
6 Through 10 Hours Per Week	38.7	55
11 Through 15 Hours Per Week	11.3	16
16 Through 20 Hours Per Week	17.6	25
21 Or More Hours Per Week	6.3	9
Mean = 11.7 Median = 10.0		
Time Spent Communicating Technical Information Orally:		
0 Hours Per Week	5.6	8
1 Through 5 Hours Per Week	25.4	36
6 Through 10 Hours Per Week	33.8	48
11 Through 15 Hours Per Week	12.7	18
16 Through 20 Hours Per Week	10.6	15
21 Or More Hours Per Week	12.0	17
Mean = 13.0 Median = 10.0		
Change Over Past 5 Years In The Amount Of Time Spent Communicating Technical Information To Others:		
Increased	71.1	101
Stayed The Same	24.6	35
Decreased	4.2	6
Time Spent Working With Written Technical Information Received From Others:		
0 Hours Per Week	1.4	2
1 Through 5 Hours Per Week	30.3	43
6 Through 10 Hours Per Week	43.7	62
11 Through 15 Hours Per Week	9.2	13
16 Through 20 Hours Per Week	11.3	16
21 Or More Hours Per Week	4.2	6
Mean = 10.3 Median = 10.0		
Time Spent Working with Technical Information Received Orally From Others:		
0 Hours Per Week	7.7	11
1 Through 5 Hours Per Week	38.7	55
6 Through 10 Hours Per Week	35.2	50
11 Through 15 Hours Per Week	6.3	9
16 Through 20 Hours Per Week	7.7	11
21 Or More Hours Per Week	4.2	6
Mean = 8.9 Median = 8.0		
Professional Advancement And Changes In Amount Of Time Spent Working With Technical Information Received From Others:		
Increased	66.9	95
Stayed The Same	28.2	40
Decreased	4.9	7

Survey participants who write collaboratively were asked if they find writing as part of a group more or less productive (i.e., producing more written products or producing better written products) than writing alone. The responses appear in table 8. Overall, more of the respondents indicated that writing with a group is more productive than writing alone. About 49% indicated that a group is more productive and about 33% indicated that a group is less productive. About 18% indicated that a group is about as productive as writing alone.

Table 8. Influence of Group Participation on Writing Productivity

How Productive	Percentage	Number
A Group Is More Productive Than Writing Alone	48.6	53
A Group Is About As Productive As Writing Alone	18.3	20
A Group Is Less Productive Than Writing Alone	33.0	36

Survey participants were asked if, during that 6 month period, they had worked with the same group of people when producing written technical communications. About 59% (64 respondents) indicated "yes" they had worked with the same group, and about 41% indicated that they had worked with various groups. Of those who indicated that they had worked in the same group, these respondents were asked how many people were in the group. About 65% (41 respondents) indicated a group size of 2-5 people and about 18% (11 respondents) indicated a group size of 6-10 people. The mean number of people in the group was 7.1 and the median was 5.0.

Those 45 respondents who indicated "no," meaning that they did not work with the same group during the past 6 months, were asked with about how many groups they had worked. About 20% (9 respondents) reported working with 2 groups, about 29% (13 respondents) reported working with 3 groups, about 24% (11 respondents) reported working with 4 groups, about 9% (4 respondents) reported working with 5 groups, and about 11% (5 respondents) reported working with 6-10 groups. The average (mean) number of groups was $\bar{X} = 4.2$ and the median number of groups was 3.0. The number of people in each group varied. About 80% of the respondents reported working with a group of 2-5 people and about 11% reported working with a group of 6-10 people. The average (mean) number of people per group was $\bar{X} = 6.6$ and the median number of people per group was 4.0.

Technical Information Products Produced. Survey participants were given a list of technical information products. They were asked to indicate the number of these products they had written or otherwise prepared in the past 6 months and if those products had been written or prepared as part of a group. The 10 most frequently produced (alone) technical information products appear in table 9.

Survey participants were also asked to indicate the number of these products they had written or otherwise prepared in the past 6 months as part of a group. The 10 most frequently prepared (as part of a group) technical information products appear in table 10. Data shown in table 10

include the number of products produced (mean and median) and the average (mean and median) numbers of people per group.

Table 9. Technical Information Products Written or Produced Alone in the Past 6 Months

Products	Mean ($\bar{X}$)	Median
Memoranda	21.4	4.5
Letters	10.1	3.0
Drawings/Specifications	3.7	0.0
Abstracts	0.4	0.0
Audio/Visual Materials	6.4	0.0
In-house Technical Reports	1.1	0.0
Computer Program Documentation	0.5	0.0
Conference/Meeting Papers	0.8	0.0
Technical Talks/Presentations	3.9	0.0
Technical Proposals	0.8	0.0

A comparison of the data contained in tables 9 and 10 reveals more similarities than differences. The production numbers vary but the products included on both lists (products produced alone or as part of a group) are essentially identical. The average numbers of people per group for the various products produced are fairly similar in size.

Survey participants were given a list of technical information products. They were asked to indicate approximately how many times in the past 6 months they had used each of them. The 10 most frequently used technical information products appear in table 11. A comparison of the data contained in tables 9 (production) and 11 (use) reveals two differences. First, on average, more products are used than are produced. Second, there are slight differences in the types or kinds of products produced and used.

Technical Information Products -- Use, Importance, and Frequency of Use

Survey participants were asked several questions designed to obtain a greater understanding of the factors affecting the use of technical reports. In this study, technical reports were placed within the context of two technical information products: conference/meeting papers and journal articles. DoD, in-house, and NASA technical reports were included in this study.

Use. Survey participants were asked if they used the aforementioned technical information products in performing their present professional duties. Table 12 includes data regarding use.

Table 10. Technical Information Products Written or Produced as Part of a Group in the Past 6 Months

Information Products	In a Group		Average Number of People Per Group	
	Mean ($\bar{X}$)	Median	Mean ($\bar{X}$)	Median
Drawings/Specifications	2.3	0.0	7.7	4.0
Letters	1.6	0.0	3.0	3.0
Memoranda	1.1	0.0	3.2	3.0
Audio/Visual Material	1.7	0.0	5.1	4.0
Conference/Meeting Papers	0.4	0.0	3.9	3.0
In-house Technical Reports	0.8	0.0	4.0	4.0
Technical Talks/Presentations	1.6	0.0	4.6	3.0
Abstracts	0.3	0.0	3.8	3.5
Computer Program Documentation	0.2	0.0	7.7	5.0
Technical Proposals	0.8	0.0	8.1	5.0

Table 11. Technical Information Products Used in the Past 6 Months

Information Products	Mean ($\bar{X}$)	Median
Journal Articles	5.1	0.0
Memoranda	42.0	6.0
Letters	17.5	2.0
Trade/Promotional Literature	5.0	0.0
In-house Technical Reports	8.6	2.0
Abstracts	4.5	0.0
Audio/Visual Materials	18.1	2.0
Computer Program Documentation	5.1	0.0
Drawings/Specifications	22.4	6.0
Technical Talks/Presentations	11.5	2.0

Table 12. Technical Information Products Used

Information Products	Percentage	Number
Conference/Meeting Papers	66.2	90
Journal Articles	62.5	85
In-house Technical Reports	88.6	124
DoD Technical Reports	48.5	64
NASA Technical Reports	54.8	74

Importance. Survey participants were asked "how important is it for you to use the aforementioned technical information products in performing your present professional duties?" Table 13 includes data regarding the importance of use technical information products. A 5-point scale (1.0 = not at all important; 5.0 = very important) was used to measure importance.

Table 13. Importance of Technical Information Products

Information Products	Mean ($\bar{X}$) Importance	Number
Conference/Meeting Papers	2.9	141
Journal Articles	2.8	138
In-house Technical Reports	3.9	140
DoD Technical reports	2.8	135
NASA Technical reports	2.8	137

Approximately 33% (47 respondents) indicated that the use of conference/meeting papers was "very or somewhat"important to their work. Approximately 24% (33 respondents) indicated that the use of journal articles was "very or somewhat" important to their work. Approximately 76% (106 respondents) indicated that in-house technical reports were "very or somewhat" important to their work. Approximately 37% (50 respondents) and 38% (52 respondents), respectively, indicated that DoD and NASA technical reports were "very or somewhat" important to their work.

Frequency of Use. Survey participants were asked to indicate the number of times each of the five technical information products had been used in a 6 month period in the performance of their professional duties (table 14). Data are presented both as means and medians. In-house technical reports were used ($\bar{X}$ = 8.6) to a much greater extent than were the other technical information products. Journal articles ($\bar{X}$ = 5.1) were used to a lesser extent followed by DoD technical reports ($\bar{X}$ = 3.6), conference/meeting papers ($\bar{X}$ = 3.2), and NASA technical reports ($\bar{X}$ = 3.0).

Table 14. Average Number of Times (Median) Technical Information Products Used in a 6 Month Period

Information Products	Mean ($\bar{X}$) Use	Median
Conference/Meeting Papers	3.2	0.0
Journal Articles	5.1	0.0
In-house Technical Reports	8.6	2.0
DoD Technical Reports	3.6	0.0
NASA Technical Reports	3.0	0.0

Technical Information Products -- Factors Affecting Use

Even if they did not use them, survey participants were asked if they were deciding whether or not to use any of the five technical information products in performing their present professional duties, how important each of the eight characteristics (factors) would be in making that decision. For example, respondents were asked to indicate how important the factor, "they are easy to physically obtain," would be in making a decision to use conference/meeting papers. A 5-point scale (1.0 = not at all important; 5.0 = very important) was used to measure importance. The higher the number, the greater the influence of the factor on the use of conference/meeting papers. An overall mean ($\bar{X}$) rating was calculated. A mean ($\bar{X}$) rating for users and non-users of each product is presented.

Conference/Meeting Papers. The importance factor ratings for conference/meeting papers appear in table 15. The factors exerting the greatest influence on use were (1) relevant to my work ($\bar{X}$ = 4.7), (2) good technical quality ($\bar{X}$ = 4.5), (3) comprehensive data and information ($\bar{X}$ = 4.3), (4) easy to physically obtain ($\bar{X}$ = 4.1), and (5) easy to use or read ($\bar{X}$ = 4.1).

Table 15. Factors Affecting the Use of Conference/Meeting Papers

Factors	User Rating ($\bar{X}$) n = 90	Non-User Rating ($\bar{X}$) n = 46	Overall Rating ($\bar{X}$) n = 136
Are Easy To Physically Obtain	4.3	3.7	4.1
Are Easy To Use Or Read	4.3	3.8	4.1
Are Inexpensive	3.5	3.3	3.5
Have Good Technical Quality	4.6	4.3	4.5
Have Comprehensive Data And Information	4.4	4.2	4.3
Are Relevant To My Work	4.7	4.6	4.7
Can Be Obtained At A Nearby Location Or Source	3.8	3.4	3.6
Had Good Prior Experiences Using Them	3.6	3.2	3.5

Journal Articles. The importance factor ratings for journal articles appear in table 16. The factors exerting the greatest influence on use were (1) relevant to my work ($\bar{X}$ = 4.7), (2) good technical quality ($\bar{X}$ = 4.5), (3) comprehensive data and information ($\bar{X}$ = 4.2), (4) easy to use or read ($\bar{X}$ = 4.1), and (5) easy to physically obtain ($\bar{X}$ = 4.0).

Table 16. Factors Affecting the Use of Journal Articles

Factors	User Rating ($\bar{X}$) n = 85	Non-User Rating ($\bar{X}$) n = 51	Overall Rating ($\bar{X}$) n = 136
Are Easy To Physically Obtain	4.3	3.6	4.0
Are Easy To Use Or Read	4.2	3.9	4.1
Are Inexpensive	3.5	3.4	3.5
Have Good Technical Quality	4.6	4.3	4.5
Have Comprehensive Data And Information	4.3	4.1	4.2
Are Relevant To My Work	4.7	4.6	4.7
Can Be Obtained At A Nearby Location Or Source	3.8	3.4	3.7
Had Good Prior Experiences Using Them	3.6	3.1	3.4

In-House Technical Reports. The importance factor ratings for in-house technical reports appear in table 17. The factors exerting the greatest influence on use were (1) relevant to my work ($\bar{X}$ = 4.7), (2) good technical quality ($\bar{X}$ = 4.4), (3) comprehensive data and information ($\bar{X}$ = 4.3), (4) easy to physically obtain ($\bar{X}$ = 4.2), (5) and easy to use or read ($\bar{X}$ = 4.1).

DoD Technical Reports. The importance factor ratings for DoD technical reports appear in table 18. The factors exerting the greatest influence on use were (1) relevant to my work ($\bar{X}$ = 4.6), (2) good technical quality ($\bar{X}$ = 4.3), (3) comprehensive data and information ($\bar{X}$ = 4.2), (4) easy to use or read ($\bar{X}$ = 4.0), and (5) easy to physically obtain ($\bar{X}$ = 3.9).

Table 17. Factors Affecting the Use of In-house Technical Reports

Factors	User Rating ($\bar{X}$) n = 124	Non-User Rating ($\bar{X}$) n = 16	Overall Rating ($\bar{X}$) n = 140
Are Easy To Physically Obtain	4.2	3.9	4.2
Are Easy To Use Or Read	4.1	4.1	4.1
Are Inexpensive	3.0	3.3	3.0
Have Good Technical Quality	4.4	4.3	4.4
Have Comprehensive Data And Information	4.3	4.0	4.3
Are Relevant To My Work	4.8	4.5	4.7
Can Be Obtained At A Nearby Location	3.8	3.6	3.8
Had Good Prior Experiences Using Them	3.6	3.4	3.5

Table 18. Factors Affecting the Use of DoD Technical Reports

Factors	User Rating ($\bar{X}$) n = 64	Non-User Rating ($\bar{X}$) n = 68	Overall Rating ($\bar{X}$) n = 132
Are Easy To Physically Obtain	4.1	3.8	3.9
Are Easy To Use Or Read	4.1	4.0	4.0
Are Inexpensive	3.2	3.5	3.3
Have Good Technical Quality	4.5	4.2	4.3
Have Comprehensive Data And Information	4.4	4.1	4.2
Are Relevant To My Work	4.7	4.5	4.6
Can Be Obtained At A Nearby Location Or Source	3.7	3.6	3.6
Had Good Prior Experiences Using Them	3.7	3.2	3.4

NASA Technical Reports. The importance factor ratings for NASA technical reports appear in table 19. The factors exerting the greatest influence on use were (1) relevant to my work ($\bar{X} = 4.7$), (2) good technical quality ($\bar{X} = 4.4$), (3) comprehensive data and information ($\bar{X} = 4.3$), (4) easy to use or read ($\bar{X} = 4.0$), and (5) easy to physically obtain ($\bar{X} = 4.0$).

Table 19. Factors Affecting the Use of NASA Technical Reports

Factors	User Rating ($\bar{X}$) n = 74	Non-User Rating ($\bar{X}$) n = 61	Overall Rating ($\bar{X}$) n = 135
Are Easy To Physically Obtain	4.1	3.7	4.0
Are Easy To Use Or Read	4.1	3.8	4.0
Are Expensive	3.4	3.4	3.4
Have Good Technical Quality	4.5	4.2	4.4
Having Comprehensive Data And Information	4.4	4.1	4.3
Are Relevant To My Work	4.7	4.6	4.7
Can Be Obtained At A Nearby Location Or Source	3.7	3.5	3.6
Had Good Prior Experiences Using Them	3.7	3.1	3.4

Use of Computer and Information Technology

Survey participants were asked if they use computer technology to prepare (written) technical communications. Almost all (97%) (137) of the survey respondents use computer technology to prepare (written) technical information. About 60% (85) of the respondents "always" use computer technology to prepare (written) technical information. About 99% (136) indicated that computer technology had increased their ability to communicate technical information. About 83% (115) of the respondents stated that computer technology had increased their ability to communicate technical information "a lot".

From a prepared list, survey respondents were asked to indicate which computer software they used to prepare written technical communication (table 20). Word processing software was used most frequently by survey respondents, followed by spelling checkers, scientific graphics, and business graphics. Outliners and prompters and desktop publishing were "least frequently" used to prepare written technical communication.

Table 20. Use of Computer Software to Prepare Written Technical Communication

Software	Percentage	Number
Word Processing	99.3	136
Outliners And Prompters	17.7	17
Grammar And Style Checkers	54.1	59
Spelling Checkers	94.7	124
Thesaurus	58.8	57
Business Graphics	64.3	72
Scientific Graphics	74.4	87
Desktop Publishing	49.5	52

Survey respondents were also given a list of information technologies and asked, "How do you view your use of the following information technologies in communicating technical information?" Their choices included "already use it"; "don't use it, but may in the future"; and "don't use it and doubt if I will". (See table 21.) The aerospace engineers and scientists in this study use a variety of information technologies. The percentages of "I already use it" responses ranged from a high of 97% (FAX or TELEX) to a low of 16% (motion picture films).

A list, in descending order, follows of the information technologies most frequently used.

FAX or TELEX	97%
Electronic Mail	85
Electronic Networks	85
Electronic Databases	78
Video Conferencing	63

A list, in descending order, follows of the information technologies "that are not currently being used but may be used in the future."

Laser Disk/Video Disk/CD-ROM	55%
Electronic Bulletin Boards	42
Micrographics and Microforms	39
Desktop/Electronic Publishing	36
Video Conferencing	34

Table 21. Use, Nonuse, and Potential Use of Information Technologies

Information Technologies	Already Use It		Don't Use It, But May In Future		Don't Use It, And Doubt If Will	
	%	(n)	%	(n)	%	(n)
Audio Tapes And Cassettes	25.8	33	18.0	23	56.3	72
Motion Picture Films	16.4	21	20.3	26	63.3	81
Videotape	58.5	79	28.1	38	13.3	18
Desktop/Electronic Publishing	59.1	78	35.6	47	5.3	7
Computer Cassettes/Cartridge Tapes	47.2	60	27.6	35	25.2	32
Electronic Mail	85.4	117	11.7	16	2.9	4
Electronic Bulletin Boards	50.0	66	41.7	55	8.3	11
FAX or TELEX	97.1	136	2.1	3	0.7	1
Electronic Data Bases	77.6	104	20.1	27	2.2	3
Video Conferencing	63.2	86	33.8	46	2.9	4
Micrographics And Microforms	30.9	38	39.0	48	30.1	37
Laser Disk/Video Disk/CD-ROM	35.4	46	55.4	72	9.2	12
Electronic Networks	84.7	116	14.6	20	0.7	1

Use and Importance of Electronic (Computer) Networks

Survey participants were asked if they use electronic (computer) networks in their workplace in performing their present duties. About 92% of the respondents use electronic networks in performing their present duties and about 8% either do not use (4%), or do not have access to (4%) electronic networks. Survey respondents used electronic networks an average of 15.1 hours per week. (See table 22.)

Table 22. Use of Electronic (Computer) Networks in One Week

Use	Percentage	Number
0 Hours	3.1	4
1 - 10 Hours	47.3	61
11 - 25 Hours	29.5	38
26 - 50 Hours	19.4	25
51 Or More Hours	0.8	1
Mean 15.1		
Median 10.0		

Respondents who use them were also asked to rate the importance of electronic (computer) networks in performing their present duties (table 23). Importance was measured on a 5-point scale with 1 = not at all important and 5 = very important. About 86% of the respondents rated electronic networks important. About 12% rated them neither important nor unimportant, and about 2% rated electronic networks unimportant.

Table 23. Importance of Electronic (Computer) Networks

Importance	Percentage	Number
Important	86.0	111
Neither Important Nor Unimportant	11.6	15
Unimportant	2.4	3

Respondents were asked how they accessed electronic (computer) networks (table 24): mainframe terminal, personal computers, and workstations. Access via personal computer (84%) was most frequently reported. Access via mainframe terminal and workstation was reported by less than 70% of the survey respondents.

Table 24. How Electronic (Computer) Networks are Accessed

Access	%	(n)
Mainframe Terminal	25.4	33
Personal Computer	83.8	109
Workstation	43.8	57

Respondents using them were asked to indicate the purpose(s) for which they used electronic (computer) networks (table 25). Survey respondents indicated that electronic mail (90%), connect to geographically distant sites (72%), information search and retrieval using WWW (60%), accessing/searching the library's catalog (48%), and information search and retrieval using FTP (42%) represented their greatest use of electronic networks. Also noticeable is the lack of electronic network use for acquiring (ordering) documents from the library and preparing scientific papers with colleagues at geographically distant sites.

Table 25. Use of Electronic (Computer) Networks for Specific Purposes

Purpose	Percentage	Number
Connect To Geographically Distant Sites	71.7	91
Electronic Mail	89.8	115
Electronic Bulletin Boards Or Conferences	42.3	52
Access/Search The Library's Catalog	47.5	58
Order Documents From The Library	22.7	27
Search Electronic (Bibliographic) Data Bases	36.4	44
Prepare Scientific And Papers With Colleagues At Geographically Distant Sites	31.0	36
For Information Search/Data Retrieval With The Following:		
FTP	42.2	49
Gopher	25.5	28
WAIS	7.6	8
World Wide Web (WWW)	59.7	71

Survey participants who used electronic (computer) networks were asked to identify the groups with whom they exchanged messages or files (table 26). An average of 84% of the survey respondents used electronic networks to exchange files with members of their own work group and others in their organization but not in their work group.

Table 26. Use of Electronic (Computer) Networks to Exchange Messages or Files

Exchange With --	Percentage	Number
Members Of Own Work Group	86.6	110
Others In Your Organization But Not In Your Work Group	81.7	103
Others In Your Organization, Not In Your Work Group, At A Geographically Different Site	79.4	100
People Outside Your Work Group	84.8	106

Use and Importance of Libraries/Technical Information Centers

Almost all of the survey respondents indicated that their organization has a library/technical information center. About 36% of the survey respondents indicated that the library/technical information center was located in the building where they worked. About 58% of the respondents indicated that the library/technical information center was located outside the building in which they worked. Six percent of the respondents reported that their organization did not have a library/technical information center.

For 28% of the respondents, the library/technical information center was located 1 mile or less from where they worked. For about 72% of the respondents, the library/technical information center was located more than one mile from where they worked.

Survey respondents were also asked if the proximity of their work setting (e.g., office to their organization's library/technical information center) affected their use of that facility (table 27). The importance of proximity was measured on a 5-point scale with 1 = not at all important and 5 = very important. About 35% of the respondents indicated that proximity was unimportant. About 18% indicated that proximity was neither important nor unimportant. Forty-eight percent of the respondents indicated that proximity was important. Overall, survey respondents indicated that the proximity of their work setting to the library/technical information center influenced its use.

Respondents were also asked to rate the importance of the organization's library/technical information center in terms of performing their professional duties. Importance was measured on a 5-point scale with 1 = not at all important and 5 = very important (see table 28). About 50% of the aerospace engineers and scientists in the study indicated that their organization's library/technical information center was important or very important in performing their present professional duties. Approximately 33% of the survey respondents indicated that their library was neither important nor unimportant to performing their present professional duties. About 18% of respondents indicated that their organization's library/technical information center was unimportant to performing their present professional duties.

Table 27. The Influence of Proximity of the Organization's Library/Technical Information Center on Use

Proximity	Percentage	Number
Unimportant	35.0	36
Neither Important Nor Unimportant	17.5	18
Important	47.6	49
Mean 3.2		
Median 3.0		

Table 28. Importance of the Organization's Library/Technical Information Center to Performance of Present Professional Duties

Importance	Percentage	Number
Unimportant	17.5	18
Neither Important Nor Unimportant	33.0	34
Important	49.5	51
Mean 3.4		
Median 3.0		

Survey respondents were asked the number of times they had used their organization's library in the past 6 months (table 29). Survey respondents used their library/technical information center about 9 times in the past 6 months. About 23% of the survey respondents did not use their library's library in the past 6 months. Reasons for not using the organization's library are

Table 29. Use of the Organization's Library/Technical Information Center in the Past 6 Months

Number of Visits	Percentage	Number
0	23.3	31
1 - 5	41.4	55
6 - 10	13.5	18
11 - 25	15.0	20
26 - 50	5.3	7
51 - 94	---	---
95 or More	1.5	2
Mean 8.5		
Median 3.0		

shown in table 30. About 93% of the respondents' information needs were more easily met some other way. About 29% indicated that they had no information needs. About 21% indicated "have my own personal library and do not need another," and "the library is too slow in getting the information I need."

Table 30. Reasons Respondents Did Not Use A Library During the Past 6 Months

Reason	Percentage	Number
I Had No Information Needs	29.2	7
My Information Needs Were More Easily Met Some Other Way	92.6	25
Tried The Library Once Or Twice Before But I Couldn't Find The Information I Needed	4.5	1
The Library Staff Is Not Cooperative Or Helpful	---	---
The Library Staff Does Not Understand My Information Needs	---	---
The Library Did Not Have The Information I Need	18.2	4
I Have My Own Personal Library And Do Not Need Another Library	21.7	5
The Library Is Too Slow In Getting The Information I Need	21.7	5
We Have To Pay To Use The Library	---	---
We Are Discouraged From Using The Library	8.7	2

FINDINGS

Readers should note that the data contained in this report reflect the responses of U.S. aerospace engineers and scientists who members of the American Institute of Aeronautics and Astronautics. The results are not generalizable to (1) U.S. aerospace engineers and scientists who are members of other professional societies, (2) all U.S. aerospace engineers and scientists, or (3) aerospace engineers and scientists employed outside of the U.S.

1. The "average" participant works in industry (100%), has a master's degree (50.7%), has an average of 22.4 years of work experience in aerospace, was educated as and works as an engineer (94%, 89%), works in design/development (62%), and is male (97%).

2. Their most important job-related project, task, or problem worked on in the past 6 months was categorized as design/development (70%); 86% of the participants worked on this project, task, or problem with others. The mean number of groups involved was 4.8, and the mean number of people in a work group was 10.4. Engineering duties predominated (77%) followed by management duties (21%) in the completion of the most important job-related project, task, or problem worked on in the past 6 months.

3. A positive and significant correlation was found between the overall complexity and technical uncertainty of the most important job-related project, task, or problem that respondents had worked on in the past 6 months.

4. To complete their most important job-related project, task, or problem, respondents first went to their personal stores of technical information (62%); next, spoke with coworker(s) inside the organization (52%); third, spoke with colleagues outside of the organization (40%); fourth, used literature resources in my organization's library (29%), fifth, searched (or had someone search for me) an electronic (bibliographic) database (15%), and sixth, spoke with a spoke with a librarian/technical information specialist (10%). About 53% and 40%, respectively, did not speak to a librarian or search (or have searched) electronic data bases to complete their most important job-related project, task, or problem.

5. Approximately 70% of the respondents reported using the results of federally funded aerospace R&D in their work. Of the six sources most frequently used to find out about the results of federally funded aerospace R&D, half involve interpersonal communication and half are formal communication. Two of the five "federal initiatives" (i.e., NASA and DoD technical reports and NASA and DoD contacts) were among the six sources used most frequently to learn about the results of federally funded aerospace R&D. However, three of the five "federal initiatives" were used least often to learn about the results of federally funded aerospace R&D.

6. About 55% of the respondents had used the results of federally funded aerospace R&D to complete their most important job-related project, task, or problem during the last 6 months. About 66% of this group indicated that federally funded aerospace R&D was "important" or "very important" for completing this work. About 60% (47) of those who used the results of federally funded aerospace R&D in completing their most important job-related project, task, or problem indicated that the results were published in either a NASA or DoD technical report.

7. Of the respondents who used the results of federally funded aerospace R&D in completing their most important job-related project, task, or problem, 67% indicated that the "time and effort it took to locate the results" was a problem, and 64% reported that the "time and effort it took to obtain the results" was a problem.

8. About 94% of the respondents indicated that it was important to communicate technical information effectively; respondents spent an average of 11.7 hours per week producing written material and 13.0 hours per week communicating information orally. Over the past 5 years approximately 71% have increased the amount of time they spend communicating information to others. Survey respondents reported spending an average of 10.3 hours per week working with written information received from others and an average of 8.9 hours per week working with information received orally from others. About 67% of the respondents indicated that the amount of time they spend working with technical information received from others has increased as they have advanced professionally.

9. About 23% of the respondents reported that all of the written technical communications they prepared involved writing alone. About 57% indicated that their written technical communications involved writing with one other person. About 59% indicated that their written technical communications involved writing with a group of two to five people. About 29% indicated that their written technical communications involved writing with a group of more than five people.

10. In terms of the perceived productivity of collaborative writing, more of the respondents indicated that writing with a group is more productive than writing alone. About 49% indicated that a group is more productive and about 33% indicated that a group is less productive. About 18% indicated that a group is about as productive as writing alone.

11. A comparison of the technical information products produced and used reveals that on average, the survey respondents used more products than they produce. There are also slight differences in the types of technical information products produced and used.

12. Survey respondents were asked to indicate their use of and the importance to them of five technical information products. In-house technical reports were most frequently used ($\bar{X} = 8.6$) and were rated most important ($\bar{X} = 3.9$). DoD and NASA technical reports were used by about 49% and 55% of the respondents and the mean importance ratings were 2.8 and 2.8 respectively.

13. Both users and non-users of the five information products were asked to indicate about the importance of eight factors in deciding whether to use any of the five information products. Overall, the factors exerting the greatest influence on decisions to use products follow.

Conference/meeting papers -- (1) relevant to my work, (2) good technical quality, (3) comprehensive data and information, (4) easy to physically obtain, and (5) easy to use or read.

Journal articles -- (1) relevant to my work, (2) good technical quality, (3) comprehensive data and information, (4) easy to use or read, and (5) easy to physically obtain.

In-house technical reports -- (1) relevant to my work, (2) good technical quality, (3) comprehensive data and information, (4) easy to physically obtain, and (5) easy to use or read.

DoD technical reports -- (1) relevant to my work, (2) good technical quality, (3) comprehensive data and information, (4) easy to use or read, and (5) easy to physically obtain.

NASA technical reports -- (1) relevant to my work, (2) good technical quality, (3) comprehensive data and information, (4) easy to use or read, and (5) easy to physically obtain.

14. About 97% of the survey participants used computer technology to prepare written technical communications; about 99% of them indicated that computer technology had increased their ability to communicate technical information.

15. Word processing and spelling checkers were the computer software used most often in preparing written technical information.

16. FAX or TELEX, electronic mail, electronic networks, electronic data bases, and video conferencing were used most frequently by survey respondents.

17. About 92% of the survey participants used electronic networks in performing their present professional duties; they use electronic networks an average of 15.1 hours per week; and about 86% rated them important in terms of performing their present professional duties.

18. About 84% of the respondents access electronic networks via personal computer; about 90% use electronic networks for electronic mail.

19. Survey respondents (50%) indicated that the organization's library/technical information center was important in performing their present professional duties.

20. On average, survey respondents visited their organization's library/technical information center 9 times in a 6 month period; survey respondents indicated that the proximity of the work setting to the organization's library/technical information center influenced its use.

21. The most common reasons for not using the organization's library/technical information center included "my information needs were more easily met some other way," "I had no information needs," "I have my own personal library and do not need another," and "the library is too slow in getting the information I need."

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APPENDIX A: PROJECT FACT SHEET

NASA/DoD AEROSPACE KNOWLEDGE DIFFUSION RESEARCH PROJECT

Fact Sheet

The process of producing, transferring, and using scientific and technical information (STI), which is an essential part of aerospace research and development (R&D), can be defined as *Aerospace Knowledge Diffusion*. Studies tell us that timely access to STI can increase productivity and innovation and help aerospace engineers and scientists maintain and improve their professional skills. These same studies indicate, however, that we know little about aerospace knowledge diffusion or about how aerospace engineers and scientists find and use STI. To learn more about this process, we have organized a research project to study knowledge diffusion. Sponsored by NASA and the Department of Defense (DoD), the *NASA/DoD Aerospace Knowledge Diffusion Research Project* is being conducted by researchers at the NASA Langley Research Center, the Indiana University Center for Survey Research, and Rensselaer Polytechnic Institute. This research is endorsed by several aero- space professional societies including the AIAA, RAeS, and DGLR and has been sanctioned by the AGARD and AIAA Technical Information Panels.

This 4-phase project is providing descriptive and analytical data about the flow of STI at the individual, organizational, national, and international levels. It is examining both the channels used to communicate STI and the social system of the aerospace knowledge diffusion process. Phase 1 investigates the information-seeking habits and practices of U.S. aerospace engineers and scientists, in particular their use of government-funded aerospace STI. Phase 2 examines the industry-government interface and emphasizes the role of the information intermediary in the knowledge diffusion process. Phase 3 concerns the academic-government interface and emphasizes the information intermediary-faculty-student interface. Phase 4 explores the information-seeking behaviors of non-U.S. aerospace engineers and scientists from Western European nations, India, Israel, Japan, and the former Soviet Union.

The results of this research project will help us to understand the flow of STI at the individual, organizational, national, and international levels. The findings can be used to identify and correct deficiencies; to improve access and use; to plan new aerospace STI systems; and should provide useful information to R&D managers, information managers, and others concerned with improving access to and utilization of STI. These results will contribute to increasing productivity and to improving and maintaining the professional competence of aerospace engineers and scientists. The results of our research are being shared freely with those who participate in the study.

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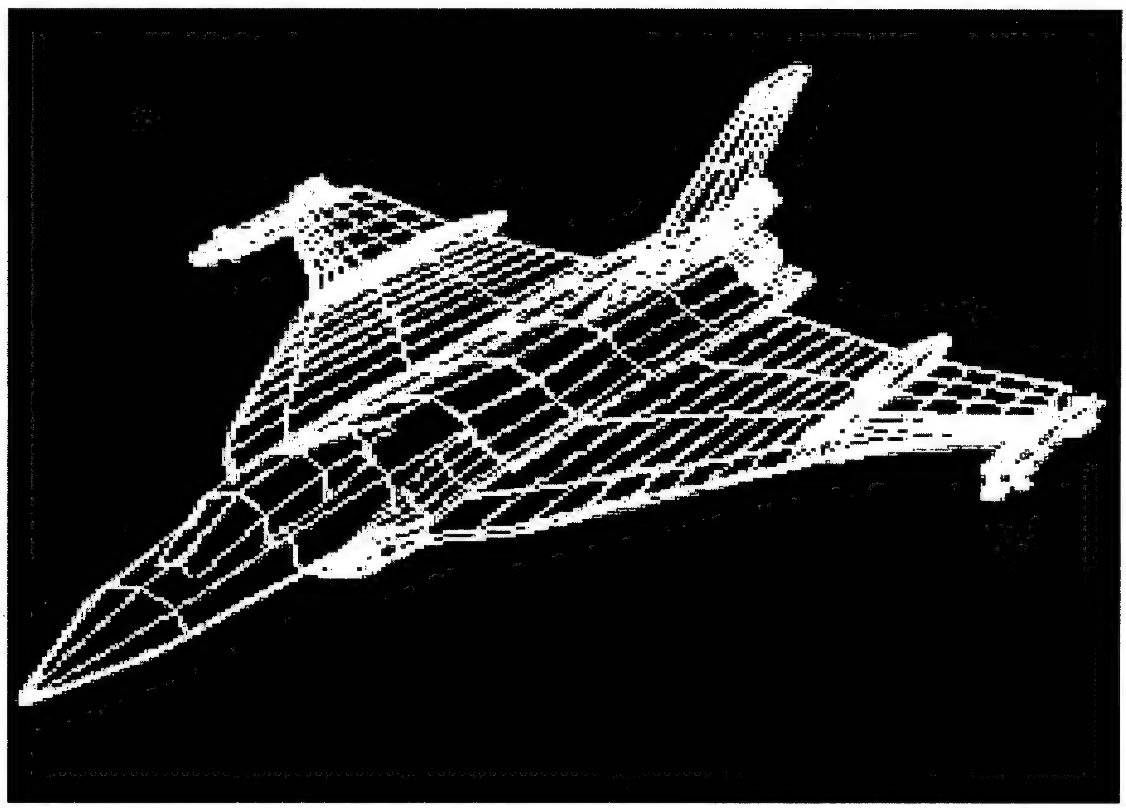
APPENDIX B: SURVEY INSTRUMENT

PHASE 1 OF THE
NASA/DOD AEROSPACE KNOWLEDGE
DIFFUSION RESEARCH PROJECT

Technical Communications in Aerospace: The Aircraft Design Perspective

The American Institute of Aeronautics and Astronautics Survey



SPONSORED BY THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION AND THE DEPARTMENT OF DEFENSE WITH THE COOPERATION OF INDIANA UNIVERSITY

The first group of questions ask about your use of technical information.

1. In your work, how important is it for you to *communicate* (e.g., produce written materials or oral discussions) technical information *effectively*? (Circle number)

   Not at all important 1 2 3 4 5 Very Important

2. In the past 6 months, about how many hours did you spend each week communicating (*producing*) technical information?

   (Output) ________ hours per week writing
   ________ hours per week communicating orally

3. Compared to 5 years ago, how has the amount of time you spend *communicating* technical information changed? (Circle ONE number)

   1 Increased
   2 Stayed the same
   3 Decreased

4. In the past 6 months, about how many hours did you spend each week working with technical information *received from others*?

   (Input) ________ hours per week working with written information
   ________ hours per week receiving information orally

5. As you have advanced professionally, how has the amount of time you spend working with technical information *received from others* changed? (Circle ONE number)

   1 Increased
   2 Stayed the same
   3 Decreased

6. In the past 6 months, about what percentage of your written technical communications involved:

   Writing alone ________% → (If 100%, go to question 9.)
   Writing with one other person ________%
   Writing with a group of 2 to 5 people ________%
   Writing with a group of more than 5 people ________%
   100 %

7. In general, do you find writing as part of a group more or less productive (i.e., producing more written products or better written products) than writing alone? (Circle ONE number)

   1 A group is *less* productive than writing alone
   2 A group is *about* as productive as writing alone
   3 A group is *more* productive than writing alone
   4 Difficult to judge; no experience preparing technical information

8. In the past 6 months, did you work with the same group of people when producing written technical information? (Circle ONE number)

   1 Yes → About how many people were in the group? number of people ________
   2 No → With about how many groups did you work? number of groups ________
   ↓
   About how many people were in each group? number of people ________

9. Approximately how many times in the past 6 months did you *write or prepare* the following alone or in a group? (If in a group, how many people were in each group?)

	Times Wrote or Prepared in Past 6 Months		
	Alone	In a Group	Average Number of People in Group
a. Abstracts	______	______	______
b. Journal Articles	______	______	______
c. Conference/Meeting Papers	______	______	______
d. Trade/Promotional Literature	______	______	______
e. Drawings/Specifications	______	______	______
f. Audio/Visual Materials	______	______	______
g. Letters	______	______	______
h. Memoranda	______	______	______
i. Technical Proposals	______	______	______
j. Technical Manuals	______	______	______
k. Computer Program Documentation	______	______	______
l. In-house Technical Reports	______	______	______
m. DoD Technical Reports	______	______	______
n. NASA Technical Reports	______	______	______
o. Technical Talks/Presentations	______	______	______

10. Approximately how many times in the past 6 months did you *use* the following as part of your professional duties?

	Times Used in Past 6 Months
a. Abstracts	______
b. Journal Articles	______
c. Conference/Meeting Papers	______
d. Trade/Promotional Literature	______
e. Drawings/Specifications	______
f. Audio/Visual Materials	______
g. Letters	______
h. Memoranda	______
i. Technical Proposals	______
j. Technical Manuals	______
k. Computer Program Documentation	______
l. In-house Technical Reports	______
m. DoD Technical Reports	______
n. NASA Technical Reports	______
o. Technical Talks/Presentations	______

Next, a few questions about computer use.

11. Do you use computer technology to prepare technical information? (Circle ONE number)

1 Always
2 Usually → Go to question 12
3 Sometimes
4 Never → Go to question 14

12. Has computer technology increased your ability to communicate technical information? (Circle ONE number)

1 Yes, a lot
2 Yes, a little
3 No

13. Do you use any of the following software to prepare written technical information? (Circle the appropriate number for each)

	Yes	No
Word processing packages	1	2
Outliners and prompters	1	2
Grammar and style checkers	1	2
Spelling checkers	1	2
Thesaurus	1	2
Business graphics	1	2
Scientific graphics	1	2
Desktop publishers	1	2

14. How do you view your USE of the following electronic/information technologies in communicating technical information? (Circle the appropriate number for each)

Information Technologies	Already Use	Don't use but may in the future	Don't use and doubt if I will
Audio tapes and cassettes	1	2	3
Motion picture films	1	2	3
Video tape	1	2	3
Desktop/electronic publishing	1	2	3
Computer cassette/cartridge tapes	1	2	3
Electronic mail	1	2	3
Electronic bulletin boards	1	2	3
FAX or TELEX	1	2	3
Electronic data bases	1	2	3
Video conferencing	1	2	3
Micrographics and microforms	1	2	3
Laser disc/video disc/CD-ROM	1	2	3
Electronic networks	1	2	3

15. At your workplace, do you use electronic networks in performing your present duties? (Circle ONE number)

1 Yes → Go to question 16
2 No
3 No, because I do not have access to electronic networks → Go to question 21

16. At your workplace, how do you access electronic networks? (Circle all that apply)

1 By using a mainframe terminal
2 By using a personal computer
3 By using a workstation

17. How important is the use of electronic networks in performing your present duties? (Circle number)

Not at all important 1 2 3 4 5 Very Important

18. In the past week, about how many hours did you USE your electronic networks?

__________ Hours in the past week

19. **Do you use electronic networks for the following purposes? (Circle appropriate number for each)**

		Yes	No
1	To connect to geographically distant sites	1	2
2	For electronic mail	1	2
3	For electronic bulletin boards or conferences	1	2
4	To access/search the library's catalogue	1	2
5	To order documents from the library	1	2
6	To search electronic (bibliographic) databases	1	2
7	To prepare scientific and technical papers with colleagues at geographically distant sites	1	2
8	For information search and data retrieval with the following:		
	FTP	1	2
	Gopher	1	2
	WAIS	1	2
	World Wide Web (WWW)	1	2

20. **Do you USE electronic networks to communicate with:**

	Yes	No
Members of your work group	1	2
Other people in your organization at the SAME geographical site who are NOT in your work group	1	2
Other people in your organization at geographically DIFFERENT sites who are NOT in your work group	1	2
People outside your work group	1	2

We would also like to know about your use of a library or technical information center.

21. **Does your organization/company have a library/technical information center? (Circle ONE number)**

1 Yes, in my building ——→ Go to question 22
2 Yes, but not in my building ______ miles ______ minute walk → Go to question 22
3 No ——————→ Go to question 26

22. **In the past 6 months, how often did you USE your organization's library/technical information center?**

______ Number of times in past 6 months

If "0" times or you did not use your organization's library, go to question 25.

23. **To what extent does the proximity of your work setting (e.g., office) to your organization's library/technical information center affect your use of it? (Circle ONE number)**

Not at all important 1 2 3 4 5 Very Important

24. **In terms of performing your present professional duties, how important is your organization's library/technical information center? (Circle ONE number)**

Not at all important 1 2 3 4 5 Very Important → Go to question 26

25. Which of the following statements describe your reasons for not using a library during the past 6 months? (Circle appropriate number for each)

	Yes	No
I had no information needs	1	2
My information needs were more easily met some other way	1	2
Tried the library once or twice before but I couldn't find the information I needed	1	2
The library staff is not cooperative or helpful	1	2
The library staff does not understand my information needs	1	2
The library did not have the information I needed	1	2
The library is too slow in getting the information I need	1	2
I have my own personal library and do not need another library	1	2
We have to pay to use the library	1	2
We are discouraged from using the library	1	2

Please tell us about your use of specific information products.

26. Do you use the following information products in performing your present professional duties? (Circle appropriate number for each)

	Yes	No
Conference/Meeting papers	1	2
Journal articles	1	2
Technical reports - In-house	1	2
Technical reports - DoD	1	2
Technical reports - NASA	1	2

27. In terms of performing your present professional duties, how important is each of the following information sources? (Circle appropriate number for each)

	Not at all Important				Very Important
Conference/Meeting papers	1	2	3	4	5
Journal articles	1	2	3	4	5
Technical reports - In-house	1	2	3	4	5
Technical reports - DoD	1	2	3	4	5
Technical reports - NASA	1	2	3	4	5

28. If you were deciding whether or not to use **conference/meeting papers** in your work, how important would the following factors be? (Circle appropriate number)

	Not at all Important				Very Important
Are easy to physically obtain	1	2	3	4	5
Are easy to use or read	1	2	3	4	5
Are inexpensive	1	2	3	4	5
Have good technical quality	1	2	3	4	5
Have comprehensive data and information	1	2	3	4	5
Are relevant to my work	1	2	3	4	5
Can be obtained at a nearby location or source	1	2	3	4	5
Had good prior experience using them	1	2	3	4	5

29. If you were deciding whether or not to use **journal articles** in your work, how important would the following factors be? (Circle appropriate number)

	Not at all Important				Very Important
Are easy to physically obtain	1	2	3	4	5
Are easy to use or read	1	2	3	4	5
Are inexpensive	1	2	3	4	5
Have good technical quality	1	2	3	4	5
Have comprehensive data and information	1	2	3	4	5
Are relevant to my work	1	2	3	4	5
Can be obtained at a nearby location or source	1	2	3	4	5
Had good prior experience using them	1	2	3	4	5

30. If you were deciding whether or not to use **in-house technical reports** in your work, how important would the following factors be? (Circle appropriate number)

	Not at all Important				Very Important
Are easy to physically obtain	1	2	3	4	5
Are easy to use or read	1	2	3	4	5
Are inexpensive	1	2	3	4	5
Have good technical quality	1	2	3	4	5
Have comprehensive data and information	1	2	3	4	5
Are relevant to my work	1	2	3	4	5
Can be obtained at a nearby location or source	1	2	3	4	5
Had good prior experience using them	1	2	3	4	5

31. If you were deciding whether or not to use **DoD technical reports** in your work, how important would the following factors be? (Circle appropriate number)

	Not at all Important				Very Important
Are easy to physically obtain	1	2	3	4	5
Are easy to use or read	1	2	3	4	5
Are inexpensive	1	2	3	4	5
Have good technical quality	1	2	3	4	5
Have comprehensive data and information	1	2	3	4	5
Are relevant to my work	1	2	3	4	5
Can be obtained at a nearby location or source	1	2	3	4	5
Had good prior experience using them	1	2	3	4	5

32. **If you were deciding whether or not to use NASA technical reports in your work, how important would the following factors be? (Circle appropriate number)**

	Not at all Important				Very Important
Are easy to physically obtain	1	2	3	4	5
Are easy to use or read	1	2	3	4	5
Are inexpensive	1	2	3	4	5
Have good technical quality	1	2	3	4	5
Have comprehensive data and information	1	2	3	4	5
Are relevant to my work	1	2	3	4	5
Can be obtained at a nearby location or source	1	2	3	4	5
Had good prior experience using them	1	2	3	4	5

33. **(Even if you don't use them...) What is your opinion of conference or meeting papers? (Circle Number)**

They are easy to physically obtain	1	2	3	4	5	They are difficult to physically obtain
They are easy to use or read	1	2	3	4	5	They are difficult to use or read
They are inexpensive	1	2	3	4	5	They are expensive
They are of good technical quality	1	2	3	4	5	They are of poor technical quality
They have comprehensive data and information	1	2	3	4	5	They have incomplete data and information
They are relevant to my work	1	2	3	4	5	They are irrelevant to my work
They can be obtained at a nearby location or source	1	2	3	4	5	They must be obtained from a distant location or source
I've had good prior experiences using them	1	2	3	4	5	I've had bad prior experiences using them

34. **(Even if you don't use them...) What is your opinion of journal articles? (Circle Number)**

They are easy to physically obtain	1	2	3	4	5	They are difficult to physically obtain
They are easy to use or read	1	2	3	4	5	They are difficult to use or read
They are inexpensive	1	2	3	4	5	They are expensive
They are of good technical quality	1	2	3	4	5	They are of poor technical quality
They have comprehensive data and information	1	2	3	4	5	They have incomplete data and information
They are relevant to my work	1	2	3	4	5	They are irrelevant to my work
They can be obtained at a nearby location or source	1	2	3	4	5	They must be obtained from a distant location or source
I've had good prior experiences using them	1	2	3	4	5	I've had bad prior experiences using them

35. (Even if you don't use them...) What is your opinion of in-house technical reports? (Circle Number)

They are easy to physically obtain	1	2	3	4	5	They are difficult to physically obtain
They are easy to use or read	1	2	3	4	5	They are difficult to use or read
They are inexpensive	1	2	3	4	5	They are expensive
They are of good technical quality	1	2	3	4	5	They are of poor technical quality
They have comprehensive data and information	1	2	3	4	5	They have incomplete data and information
They are relevant to my work	1	2	3	4	5	They are irrelevant to my work
They can be obtained at a nearby location or source	1	2	3	4	5	They must be obtained from a distant location or source
I've had good prior experiences using them	1	2	3	4	5	I've had bad prior experiences using them

36. (Even if you don't use them...) What is your opinion of DoD technical reports? (Circle Number)

They are easy to physically obtain	1	2	3	4	5	They are difficult to physically obtain
They are easy to use or read	1	2	3	4	5	They are difficult to use or read
They are inexpensive	1	2	3	4	5	They are expensive
They are of good technical quality	1	2	3	4	5	They are of poor technical quality
They have comprehensive data and information	1	2	3	4	5	They have incomplete data and information
They are relevant to my work	1	2	3	4	5	They are irrelevant to my work
They can be obtained at a nearby location or source	1	2	3	4	5	They must be obtained from a distant location or source
I've had good prior experiences using them	1	2	3	4	5	I've had bad prior experiences using them

37. (Even if you don't use them...) What is your opinion of NASA technical reports? (Circle Number)

They are easy to physically obtain	1	2	3	4	5	They are difficult to physically obtain
They are easy to use or read	1	2	3	4	5	They are difficult to use or read
They are inexpensive	1	2	3	4	5	They are expensive
They are of good technical quality	1	2	3	4	5	They are of poor technical quality
They have comprehensive data and information	1	2	3	4	5	They have incomplete data and information
They are relevant to my work	1	2	3	4	5	They are irrelevant to my work
They can be obtained at a nearby location or source	1	2	3	4	5	They must be obtained from a distant location or source
I've had good prior experiences using them	1	2	3	4	5	I've had bad prior experiences using them

Next, we would like to know about the work you do.

38. Think of the most important job-related project, task, or problem you have worked on in the past 6 months. Which category best describes this work? (Circle only ONE number)

1 Research (either basic or applied)
2 Design/Development
3 Manufacturing/Production
4 Quality Assurance/Control
5 Computer Applications
6 Management (e.g., planning, budgeting, and managing research)
7 Other (specify): ______________________________

39. How would you describe the overall complexity of the technical project, task, or problem you categorized in Question 38? (Circle ONE number)

Very Simple 1 2 3 4 5 Very Complex

40. How would you rate the amount of technical uncertainty that you faced when you started the technical project, task, or problem categorized in Question 38? (Circle ONE number)

Little Uncertainty 1 2 3 4 5 Great Uncertainty

41. While you were involved in this technical project, task, or problem, did you work alone or with others?

1 Alone
2 With others ——→ In how many groups did you work? ________
About how many people were in each group? ________

42. Which one of the following best describes the kinds of duties you performed while working on the technical project, task, or problem categorized in Question 38? (Circle ONE number)

1 Engineering
2 Science
3 Management
4 Other (specify): ______________________________

43. What steps did you follow to get the information you needed for this project, task, or problem? [Please sequence these items (e.g., #1, #2, #3) and put an X beside the steps you did not use.]

________ Used my personal store of technical information, including sources I keep in my office
________ Spoke with coworkers or people inside my organization
________ Spoke with colleagues outside my organization
________ Spoke with a librarian or technical information specialist
________ Searched (or had someone search for me) an electronic (bibliographic) data base in the library
________ Used literature resources (e.g., technical reports) found in my organization's library

________ Used none of the above steps

44. Do you USE the results of federally-funded aerospace R&D in your work? (Circle ONE number)

1 Yes 2 No

45. Did you USE the results of federally-funded aerospace R&D in completing the technical project, task, or problem you categorized in Question 38? (Circle ONE number)

1 Yes 2 No ⟶ Go to question 50

46. How important were the results of federally-funded R&D in completing the technical project, task, or problem you categorized in Question 38? (Circle ONE number)

Not at all important 1 2 3 4 5 Very Important

47. Were any of these results published in either a NASA or DoD technical report? (Circle ONE number)

1 Yes 2 No

48. From which of the following sources did you learn about/obtain the results of the federally-funded aerospace R&D you used in completing the technical project, task, or problem? (Circle appropriate number for each)

	Yes	No
Coworkers inside my organization	1	2
Colleagues outside my organization	1	2
NASA and DoD contacts	1	2
Publications such as NASA *STAR*	1	2
NASA and DoD sponsored and co-sponsored conferences and workshops	1	2
NASA and DoD technical reports	1	2
Professional and society journals	1	2
Librarians inside my organizations	1	2
Trade journals	1	2
Searches of computerized data bases	1	2
Professional and society meetings	1	2
Visits to NASA and DoD facilities	1	2

49. Which, if any, of the following problems were associated with using these results? (Check ALL that apply)

_________ The time and effort it took to locate the results
_________ The time and effort it took to physically obtain the results
_________ The accuracy, precision, and reliability of the results
_________ The legibility or readability of the results
_________ The organization or format of the results
_________ The distribution limitations or security restrictions of the results

Over Please ⟶

Survey Demographics

50. Gender:

1 Male   2 Female

51. Please indicate the highest college degree you hold.

1 No college degree
2 Bachelor's
3 Master's
4 Doctorate
5 Other (specify): ______________________

52. Years of aerospace work experience: ________ years

53. Which of the following best describes your primary professional duties? (Circle ONE number)

1 Research
2 Administration/Management
3 Quality Assurance/Control
4 Design/Development
5 Manufacturing/Production
6 Flight Test
7 Marketing/Sales
8 Service/Maintenance
9 Private Consultant
10 Other (specify): ____________________

54. Was your academic preparation as an: (Circle ONE number)

1 Engineer
2 Scientist
3 Other (specify): ______________________________________

55. In your present job, do you consider yourself primarily an: (Circle ONE number)

1 Engineer
2 Scientist
3 Other (specify): ______________________________________

56. Is any of your current work funded by the federal government? (Circle ONE number)

1 Yes   2 No   3 Don't know

THANK YOU!

Mail to:

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12a. DISTRIBUTION/AVAILABILITY STATEMENT
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13. ABSTRACT *(Maximum 200 words)*
The U.S. government technical report is a primary means by which the results of federally funded research and development (R&D) are transferred to the U.S. aerospace industry. However, little is known about this information product in terms of its actual use, importance, and value in the transfer of federally funded R&D. To help establish a body of knowledge, the U.S. government technical report is being investigated as part of the *NASA/DoD Aerospace Knowledge Diffusion Research Project*. In this report, we summarize the literature on technical reports and provide a model that depicts the transfer of federally funded aerospace R&D via the U.S. government technical report. We present results from our investigation of aerospace knowledge diffusion vis-á-vis the U.S. government technical report, and present the results of research that investigated aerospace knowledge diffusion vis-á-vis the technical communication practices of U.S. aerospace engineers and scientists who were members of the American Institute of Aeronautics and Astronautics.

14. SUBJECT TERMS
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